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IMPLEMENTATION SCIENCE (E GENG, SECTION EDITOR)

A Review of Differentiated Service Delivery for HIV Treatment: Effectiveness, Mechanisms, Targeting, and Scale

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Abstract

Purpose of Review Differentiated service delivery (DSD) models were initially developed as a means to combat suboptimal long-term retention in HIV care, and to better titrate limited health systems resources to patient needs, primarily in low-income countries. The models themselves are designed to streamline care along the HIV care cascade and range from individual to group-based care and facility to community-based health delivery systems. However, much remains to be understood about how well and for whom DSD models work and whether these models can be scaled, are sustainable, and can reach vulnerable and high-risk populations. Implementation science is tasked with addressing some of these questions through systematic, scientific inquiry. We review the available published evidence on the implementation of DSD and suggest further health systems innovations needed to maximize the public health impact of DSD and future implementation science research directions in this expanding field.

Recent Findings While early observational data supported the effectiveness of various DSD models, more recently published trials as well as evaluations of national scale-up provide more rigorous evidence for effectiveness and performance at scale. Deeper understanding of the mechanism of effect of various DSD models and generalizability of studies to other countries or contexts remains somewhat limited. Relative implementability of DSD models may differ based on patient preference, logistical complexity of model adoption and maintenance, human resource and pharmacy supply chain needs, and comparative cost-effectiveness. However, few studies to date have evaluated comparative implementation or cost-effectiveness from a health systems perspective.

Summary While DSD represents an exciting and promising "next step" in HIV health care delivery, this innovation comes with its own set of implementation challenges. Evidence on the effectiveness of DSD generally supports the use of most DSD models, although it is still unclear which models are most relevant in diverse settings and populations and which are the most cost-effective. Challenges during scale-up highlight the need for accurate differentiation of patients, sustainable inclusion of a new cadre of health care worker (the community health care worker), and substantial strengthening of existing pharmacy supply chains. To maximize the public health impact of DSD, systems need to be patient-centered and adaptive, as well as employ robust quality improvement processes.

Keywords Differentiated service delivery · Sub-Saharan Africa · HIV · Implementation science · Patient-centered care

This article is part of the Topical Collection on *Implementation Science*

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Introduction

Health systems in sub-Saharan Africa have continued to evolve in response to the changing global HIV/AIDS epidemic. Early in the epidemic response, health systems were challenged to rapidly scale-up antiretroviral therapy (ART) and care for acutely ill patients. As the response gathered momentum, decentralization and task-shifting were implemented to address emerging systems constraints. In the current era of universal ART, health systems have the dual challenge of initiating greater numbers of individuals on treatment while also providing chronic, life-long care to a growing number of healthy, and yet diverse groups of people. As a result, sustained retention in care has emerged as a key challenge in the current HIV/AIDS response and in achieving the "90-90-90" goals set forth by UNAIDS. Differentiated service delivery (DSD) was developed as a means to combat suboptimal long-term retention by "simplifying and adapting care" along the cascade, guided by patient preferences and needs, while at the same time, "reducing unnecessary burdens" on individuals and the health system [1].

Although some DSD models represent a continuation of decentralization (to health posts, communities, and patient homes) and task-shifting (to lay health care workers and patients), not all models follow this pattern. DSD models run the gamut from community to facility-based, client-driven to health care worker-driven, and group-based to individual strategies (Fig. 1) [1]. What all models do have in common is that they attempt to vary the intensity, frequency, and location of services based on patient preference and need [3]. Although initially designed to provide care for stable adults on ART, DSD models have since evolved to include patients with advanced or virologically detectable disease as well as children, adolescents, pregnant patients, and patients with co-morbidities (e.g., tuberculosis and non-communicable diseases).

While the intent of DSD models is to titrate service intensity to meet patient needs without compromising service quality and health outcomes, much remains to be understood about whether and how well specific DSD interventions actually work (effectiveness), how they work (mechanism of intervention effect), for whom they work (generalizability and transportability), whether they work at scale, and whether they help those at greatest risk of falling out of care (reach). It is precisely these types of real-world questions that the burgeoning field of implementation science is concerned with answering. We review the available published evidence on the implementation of DSD and suggest further health systems innovations needed to maximize the public health impact of DSD and future implementation science research directions in this expanding field.

Do DSD Interventions Work? (Effectiveness)

Data supporting the effectiveness of DSD interventions were initially limited to observational studies of pilot programs [4–12]. Some of these early findings have since been corroborated by evaluations at-scale in both Mozambique and South

Health system-driven ⟷ Patient-driven

	Key objectives	Appointment spacing and fast-track drug refill	Adherence clubs: Facility-based clubs	Adherence clubs: Community-based clubs	Community ART distribution points	Community ART groups (CAGs)
Patient's perspective	Reduce costs (time + transport)	▪ Reduction of clinical visits ▪ Less time spent at clinic for drug refills	▪ Reduction of clinical visits ▪ Less time spent at clinic for drug refill	▪ Reduction of clinical visits ▪ Reduction of distance for drug refill	▪ Reduction of clinical visits ▪ Reduction of distance for drug refill	▪ Reduction of clinical visits ▪ Reduction of distance for drug refill
Patient's perspective	Increase peer support	No	At club in health facility and potentially beyond into community	At club in community and beyond	At distribution point by expert patient	At CAG meeting in community and beyond
Patient's perspective	Enhance community participation	No	Potentially	Potentially	Potentially	Potentially
Health care service perspective	Reduce workload					
Health care service perspective	▪ nurse	Yes	Yes	Yes	Yes	Yes
Health care service perspective	▪ pharmacist	Yes	No	No	Yes	Yes
Health care service perspective	▪ counsellor, community health worker, expert patient	-	No (facilitation by club)	No (facilitation by club)	No (distribution and monitoring)	No (formation, training and supervision of CAG)
Health care service perspective	Maintain/improve health outcomes					
Health care service perspective	▪ adherence	Unknown	Yes	Unknown	Unknown	Unknown
Health care service perspective	▪ retention	Yes	Yes	Unknown	Yes	Yes
Health care service perspective	Improve self-management of patients	Individual patient empowerment	Adherence support	Aherence support and tracing	Organization of services for drug refill, adherence support, tracing and testing	Drug refill, adherence support, tracing and testing

Fig. 1 Summary of differentiated service delivery models (reprinted with permission from Bemelmans M, Baert S, Goemaere E, et al. Community-supported models of care for people on HIV treatment in sub-Saharan Africa. *Trop Med Int Health.* 2014;19 [8]:968–977) [2]

Africa [13, 14] as well as in experimental trials [15]. Most studies have focused on evaluating intervention effect on retention, a smaller number on viral load suppression, and even fewer on mortality. While the majority of these studies provide support for the effectiveness of differentiating service delivery, not all evidence is positive.

Group-Based/Client-Managed Models: Community ART Groups

Although evaluations of Community ART Groups (CAGs) have consistently shown substantial reductions in loss to follow-up, potential selection bias limits our ability to comment on model effectiveness. CAGs are small groups of patients who rotate clinical follow-up care and drug pick-up duties at the facility and meet in the community monthly for group drug distribution and peer support. The earliest CAG analyses from Mozambique reported 1-year retention > 97% and 4-year retention at 91.8% [4, 16]. A major limitation of these early studies was the lack of a comparator group and the risk of selection bias as only patients electing to join the CAG model were evaluated and these patients may inherently be more likely to be retained in care. CAG uptake has been shown to be *higher* among women and clients with lower education/socioeconomic status and *lower* among men, migrant populations, and clients unwilling to disclose HIV status, with fears of inadvertent disclosure in the community, or with weak social networks [13, 17–19].

Since then, a large cohort study at 68 facilities in Mozambique utilized propensity score matching to compare outcomes among patients in CAGs to matched controls who were eligible, but not in CAGs [20]. These data showed non-CAG participants were more than twice as likely to be lost to follow-up (LTFU) compared with CAG participants (HR 2.356; $p = 0.04$) but no difference in mortality was found between groups. The covariates included in the propensity score, however, likely did not predict the likelihood of choosing to join a CAG and may therefore have not fully addressed selection bias. A complementary analysis utilizing the same CAG participant cohort, but this time comparing CAGs to non-CAG participants at 170 of 288 (60%) of all adult ART facilities in Mozambique and including CAG participation as a time-varying covariate, yielded similar findings [13]. A growing body of literature from other countries (Lesotho, Swaziland, Kenya, Haiti) provides additional observational evidence to support CAG effectiveness [21–24]. Randomized data on the effectiveness of CAGs compared with standard of care (Community ART study in Zambia) and of 3-vs 6-monthly ART dispensation in CAGs (MMSD study in Zimbabwe) are forthcoming.

Group-Based/Health Care Worker–Managed Models: Adherence Clubs

Effectiveness data on adherence clubs (AC) comes primarily from South Africa, and although generally very promising, has recently yielded mixed results. ACs are groups of approximately 30 patients who meet every 2 to 3 months for group-based drug pick-up and counseling either in the facility or community and who receive clinical follow-up care every 6 or 12 months. Early pilot studies in Cape Town, South Africa, demonstrated a 57% reduction in the risk of loss to follow-up (LTFU) and 67% reduction in the risk of virologic rebound compared with facility-based care [5, 25, 26]. These were conducted at single sites, leaving some question as to the generalizability of study findings to other countries and at scale. However, by 2015, ACs had been scaled to over 32,000 patients and in an analysis of a representative sample of 10% of this population, retention paralleled those found in the earlier pilots: 95.2% and 89.3% retention at 1 and 2 years respectively [14]. ACs were also effective in reducing incidence of late drug pick-up (greater than 7 days late) by four-fold in a cluster randomized trial in Zambia [15].

However, our understanding of AC model effectiveness has been recently complicated by reports of high LTFU and sub-optimal meeting attendance. Observational analyses in South Africa and Kenya have reported 36-month LTFU from ACs as high as 26% [27–29]. In the Kenyan study, the most common reasons for withdrawal were relocation (31%), perceived stigma associated with attending meetings (17%), and patient request to discontinue participation (14%) [29]. A randomized trial in South Africa comparing facility-based versus community-based ACs also showed poor retention in club-based care in both arms at 24 months (57% vs 48% respectively) [30]. Meeting non-attendance with failed drug pick-up was the most common reason for club dismissal. However, retention in any care exceeded 88% in both arms despite poor retention in a club, which may represent a "settling out" effect in which people ultimately select the care that works best for them over time.

Individual, Facility-Based Models: Visit Spacing, Multi-month Refills, Streamlined ART Pick-up

Data from individual, facility-based models have been universally positive, albeit some studies demonstrated small effect sizes and the wide variety of effectiveness outcomes measured make it difficult to compare outcomes between studies [6–10, 31–33]. These models include any combination of clinical visit spacing, multi-month drug refills (pharmacy visit spacing), and streamlined (fast-track) facility-based drug pick-up. Observational data from multiple settings are available (Uganda, Malawi, DRC, Guinea, Zambia, Nigeria) which highlight decreases in LTFU, missed visits, and medication gaps as well as improvements in patient wait time and provider/patient ratios with increased visit spacing. An ongoing cluster RCT in Malawi and Zambia, the INTERVAL study, will provide the first experimental evidence for the effectiveness of standard of care vs 3- and 6-month ART refills in improving retention in care and virologic suppression [34].

Individual, Community-Based Models: Home Delivery, Community Drug Distribution Points, Mobile ART Delivery

Published effectiveness data on individual, community-based models, which span home delivery, fixed community drug distribution points, and mobile ART delivery, have yielded mixed results in pilots and are yet to be widely scaled. Non-inferiority of health outcomes with home-based care compared with facility-based care was established early-on with two randomized trials in Uganda and Kenya [35, 36] and more recently in Ethiopia [37]. Lack of feasibility of home-based care as client numbers grew prompted TASO in Uganda to develop Community Drug Distribution Points (CDDP) (e.g., drug distribution at community pharmacies, health posts). [11, 38, 39] Cross-sectional assessment of a cohort of patients initiated on ART and enrolled in CDDP between 2004 and 2009 revealed retention of only 69% and death of 17% after 5 years of treatment [11]. Additional analyses showed more promising results but are yet to be published [38, 39]. More favorable results were seen in an MSF pilot of community drug distribution in the Democratic Republic of Congo (PODI) where overall attrition (death, LTFU, transfer out) was 5.66 per 100 person-years after 24 months of follow-up [12, 40, 41]. ATM-like ART dispensation is also being piloted in South Africa but effectiveness data is still forthcoming [42]. Data on mobile ART delivery is limited to two abstracts: one from Swaziland [22], which demonstrated only 77% retention at 12 months, and the second from South Africa, [43] which reported 91.2% virologic suppression and little LTFU (2%) among migrant farm workers on the South African-Zimbabwean border. Randomized data on mobile ART strategies is forthcoming from the DOART trial in Uganda and South Africa in which three models will be compared: (i) Home ART initiation and mobile van ART monitoring and resupply, (ii) Clinic ART initiation and mobile van ART monitoring and resupply, and (iii) Clinic ART initiation, monitoring, and resupply.

How Do DSD Interventions Work? (Mechanism of Intervention Effect)

While published data generally support the effectiveness of DSD models, inadequate understanding of how DSD interventions actually work has limited our ability to determine whether findings from a given study can be generalized and/or replicated across heterogenous socioeconomic, geographical, and cultural settings. There also remain important questions about the most critical elements needed for the success of individual models and about which models are best suited for different settings. Intervention mechanism of effect refers to the steps or processes through which the intervention translates into events or actions that lead to the outcome, or precisely what was altered that led to behavior change. Identification of DSD mechanism of effect has been qualitatively explored for CAGs [17, 18, 20, 21, 44, 45] and ACs [46–53]. However, no studies have yet quantitatively measured potential mediators of effect (factors which shows a statistical association and causal link between the intervention and outcome) or moderators of effect (factors which influence the direction or magnitude of the relation between the intervention and outcome).

In theory, DSD models work on multiple levels to improve retention in care and viral load suppression. Adherence and retention barriers have been previously well studied and include a wide range of factors that are "structural" or due to the external environment (e.g., transportation costs, work); "clinic-based" or due to the healthcare environment (e.g., waiting times, provider attitudes); or "patient-based" or due to knowledge, beliefs, or attitudes of patients within a given social context (e.g., denial, stigma, preference for spiritual healing) [54, 55]. Heretofore, adherence and retention interventions have primarily focused on addressing one of these barriers at a time (e.g., peer counseling, SMS, economic incentives). DSD theoretically offers a multi-modal strategy to address multiple barriers at the same time.

Structural Barriers

DSD models may address structural barriers by decreasing transport and opportunity costs from lost work by reducing visit frequency (in all models) and by bringing care closer to home (in community-based models) [17, 44, 45]. CAGs may additionally reduce costs through pooled financial resources for rotating CAG member travel to the facility [44, 45].

Clinic-Based Barriers

DSD models appear to address clinic-based barriers by reducing clinic congestion (via reduced visit frequency) and thereby waiting time [7]. Decreased provider workload and better monitoring of acutely ill patients (or those with WHO-defined "advanced disease") may also reduce provider fatigue and improve provider attitudes, thereby altering patient experience and satisfaction at the clinic [44, 45]. Qualitative studies suggest that client-driven models (CAGs) foster greater patient activation, empowerment, and disease self-management, thus altering the previously hierarchal doctor-patient relationship [20, 44, 45].

Patient-Based Barriers

DSD models reduce stigma-related patient barriers due to decreased contact with the facility [17]. Group-based models are thought to additionally foster motivation through peer support. This may play a larger role in CAGs than ACs, which were created for "Fast. Friendly. Two months [sic] supply of ARVs" and to a lesser extent for social support [56••]. A unique potential mechanism for CAGs is greater accountability due to shared drug pick-up responsibilities. Membership in an "exclusive" club and feeling treated as a "VIP," emerged as a motivator for some AC participants early-on, but dissipated as the number of clubs per clinic increased during scale-up in South Africa [47, 56••].

While many of these mechanisms are supported by existing qualitative data, quantitatively identifying their causal relationship to observed outcomes is important to understanding which mechanisms are most crucial to intervention success, and ultimately to aid policymakers and program developers in deciding which models (or model components) should be scaled or adapted for different individuals and/or populations. For example, while patient empowerment and disease self-management play a theoretical role in CAG intervention effect, it is unclear how important this is compared with the peer support received or the structural barriers addressed through the model. Similarly, while the group-based structure of ACs theoretically provides an avenue for peer support [47], quantitative data showing a large number of missed visits [15, 30] and qualitative data implying that suboptimal implementation of a supportive group environment leads to disobeyance of club rules [51], suggest that ACs may currently be acting more through convenient drug pick-up then via social support. Given this, the added complexities and cost of group formation and management may afford little benefit over the structural barriers addressed through visit spacing and fast-tracking in an individual, facility-based model. Ultimately, well-implemented group-based models may be most effective for patients with psychosocial barriers to care while patients reporting mostly structural barriers may do best with individual-based models.

The optimal way to obtain and leverage this kind of information is to investigate potential mediating factors along the causal pathway between intervention and outcome using mediation analysis. This analytic approach has already been employed to improve understanding of multicomponent interventions in the HIV/AIDS field [57].

For Whom Do DSD Interventions Work? (Generalizability and Transportability)

Knowledge of mechanism of effect is the first step in understanding the generalizability and transportability of study findings, i.e., to what extent can we use published DSD studies to infer or make conclusions about the effectiveness of these interventions in other settings. For example, can we assume that ACs (primarily studied in South Africa) will work the same way and be as effective in Rwanda or Kenya?

Historically, assessments of generalizability and transportability have been limited to subjective interpretations and expert opinion; however, a more sophisticated understanding could be obtained through a transportability framework and causal inference analysis. For example, if we first assume that the effect of a CAG on retention in care is (1) mediated by reduction in opportunity costs which is driven by distance to facility and current visit frequency and is (2) moderated by social capital. And if we then measure distance, visit frequency, and social capital, then, the observed effects can be transported to a new setting in which these same factors are measured, without further experimentation. While this type of analysis requires making other major assumptions (i.e., that there are no other differences in any variables that may affect retention in care), novel application of unique implementation science methods such as these holds some promise.

Do DSD Interventions Work at Scale and Can They Be Sustained?

While a robust theoretical understanding of how and where DSD interventions work is still nascent, key lessons have already been learned through DSD scale-up.

Differentiating Patients Based on Clinical Stability

A central aspect of DSD innovation is the concept of differentiating patients based on need. Initially, the intent was to identify clinically stable patients to receive reduced intensity and frequency of health services. However, an implementation science study of 30 purposively selected facilities in Malawi highlights the challenges with accurate differentiation in a real-world setting: 27% of patients who were eligible for multi-month scripting (based on national criteria for clinical stability) did not receive it while 42% who were ineligible did [58••]. The need to differentiate patients has also drawn attention to deficiencies in laboratory testing as access to CD4 count and viral load testing are required to identify patients with advanced disease and those who are not virologically suppressed. In an IeDeA Southern Africa network study, the authors found that in viral load monitoring sites (but not in CD4-only monitoring sites), the rate of clinic visits in stable patients was substantially lower than in unstable patients. [59] Furthermore, observational data in Zambia suggest that patient stability itself is quite dynamic and cross-sectional assessments of stability do little to reflect the complex nature of patients who transition back and forth between stability and instability [60]. Even as DSD models now strive to include clinically unstable patients, they face the same challenge of differentiating "instability."

Model Uptake and Adoption

Studies of individual patient uptake of various models have been evaluated both qualitatively and quantitatively and suggest preference for individual, facility-based models. In Nigeria, Kenya, and Zimbabwe, multi-month scripting and fast-track models were preferred over client-driven or community-based models [61–63]. Required disclosure in group-based models and inadvertent disclosure in the community were key factors cited in these studies. Discrete choice experiments are a novel analytic method that can allow for quantification of patient preferences for specific DSD model attributes. In both Kenya and Zambia (FACES and CIDRZ unpublished data), the strongest overall preference across all patients was for a reduction in clinic visit frequency. There were additional preferences for individualized care, with urban populations preferring facility-based care and rural populations favoring community-based drug collection.

DSD model adoption at the facility-level also seems to favor individual, facility-based models over group-based or community-based models. In Malawi, multi-month scripting, fast-track drug refills, and CAGs were simultaneously scaled up [58••]. At facilities offering fast-track, 77% of eligible patients were enrolled, while at facilities offering CAGs, only 6% of eligible patients were enrolled. In a study mapping the scale-up of DSD in 722 NGO-supported facilities in 13 countries, facility-based individual models were most commonly implemented [64]. One possible explanation is that group-based model expansion faces additional hurdles due to the complexities and human resource needs of group formation and ongoing group management. In Mozambique, a key anticipated challenge during national scale-up of CAGs was the human resource requirement for a new workforce cadre of community health workers and supervisory staff to assemble and monitor the CAGs [18, 65]. A health system evaluation of AC scale-up in South Africa revealed that although initial widespread adoption of the AC model was successful, after more than 40 clubs at a facility were formed, logistical complexities of group management became unmanageable (this was termed the "forty club hurdle") [56••].

Human Resource Needs

Nearly all DSD models strive to more efficiently utilize limited high-level health care worker (HCW) resources through task-shifting and are thereby increasingly dependent on community HCW. Both inadequate forecasting of HCW needs within DSD models as well as inadequate training, coordination, and compensation of community HCW have been seen as challenges to DSD scale-up [18, 66]. While several studies have already demonstrated the benefit of DSD models in reducing formal HCW provider workload ratios through decreased visit frequency [67, 68], in some settings, increased absolute numbers of ART patients (due to newly initiating clients) and new tasks such as pre-packaging of medications have offset the direct time-savings benefits experienced by health care workers [56••].

Pharmacy Supply Chain

Another key vulnerability that has emerged with DSD scale-up is gaps in pharmacy supply chain management. Programs that are able to pre-emptively plan and strengthen drug delivery systems (i.e., quantification, forecasting, and stock control) [69] prior to scale-up have fared well [70], while those that lacked this pre-planning have experienced delays in implementation, stock-outs, and client drop-outs [33, 71].

Comparative Costs and Cost-effectiveness

DSD implementation has the potential to mitigate the crisis in HIV treatment financing by providing care for more clients at the same cost [72]. While the fast-track and AC models have been found to be cost-effective when compared with standard of care [6, 73], a few studies have provided valuable costing data comparing different DSD models [58••, 74]. In Malawi, multi-month scripting, fast track, and CAGs all reduced average ART unit costs by 10% compared with standard of care, but costs across all three models were similar. In Uganda, TASO found that among three models of care, standard of care was cheapest ($257) compared with mobile ART delivery ($404) or community drug distribution points ($332). In Zambia, annual costs were most sensitive to salary levels of pharmacy technologists and the fast-track model was found to be the most costly ($92.72 annually) compared with CAG ($85.47) and AC ($27.46) [75]. Importantly, these unit costs are country-specific and do not account for possible differences in model effectiveness. Cost-effectiveness data are urgently needed and randomized comparisons are forthcoming from the DoART study in Uganda and South Africa, the INTERVAL study in Zambia and Malawi, and the MMSD study in Zimbabwe.

Relative Implementability of DSD Models

The relative implementability of any particular DSD model is likely a result of the aforementioned factors: patient preference, differential logistical complexity of model adoption and maintenance, comparative human resource and pharmacy supply chain needs, and relative cost-effectiveness. Thus far, there are few published studies directly examining implementation from a health systems perspective [56••] or comparative implementation of several DSD models within the same context [58••]. In Malawi, Prust et al., conducted a process evaluation of three different models of DSD care (multi-month scripting (MMS), fast track refills (FTR), and community adherence groups (CAGs)). MMS had been universally scaled up but the other two models were not offered at all clinics. The authors documented better differentiation of patient stability at FTR sites and lower uptake of CAGs among eligible patients, and concluded that expanding FTRs and CAGs did not afford additional cost savings compared with MMS alone. However, reasons for low CAG uptake and additional benefits to patient satisfaction or clinical outcomes have not yet been fully explored.

Do DSD Interventions Reach Vulnerable and Key Populations?

A plethora of pilots targeting children, adolescents, and pregnant or post-partum mothers provides early evidence that DSD models can close gaps in treating these vulnerable populations. For children, fast track programs [76] and multi-month scripting [77] were found to be effective. For adolescents, ACs in South Africa and "teen clubs" in Malawi [78], which include Saturday clinical visits to reduce school absenteeism and enhanced psychosocial support activities, have been successful in improving retention. ACs have also been employed for families [79] and post-partum women [80–82]. A relative advantage of group-based interventions is the added psychosocial support which may be of particular benefit to adolescents and pregnant/post-partum women.

Similarly, DSD strategies for key populations (men who have sex with men (MSM) [83], intravenous drug abusers (IVDA) [84, 85], sex workers [86–88], and transgender patients) are being piloted globally. Some of these programs allow for engagement in care along the entire HIV cascade (from HIV testing to ART initiation to ART maintenance) which is crucial for marginalized populations with decreased contact with health facilities.

Migrant populations and prisoners are two other traditionally difficult to treat populations in whom DSD models are being explored [43, 89]. In a small pilot study at the South Africa-Zimbabwean border, a successful targeted strategy for migrant workers was developed where those planning travel greater than 2 weeks were characterized as temporary transfer outs and were given a 3-month drug supply and a referral letter.

What Health Systems Innovations Are Needed to Maximize Benefits of DSD Implementation?

A crucial factor that has emerged in considering the benefits of a DSD approach is whether DSD is as truly adaptive to individual patient needs as it seeks to be, or whether there is a risk of simply replacing one rigid system with another. Inherent to this discussion is the tension between a one-size-fits-all public health approach and the risk of over-targeting. Although DSD cannot accommodate every individual's circumstances, redesign can better meet the needs of many. We suggest here several key health systems innovations which are needed to maximize the public health impact of DSD service delivery.

Patient-Centered Care

While the commonly used definition of DSD references a desire to provide patient-centered care, the two concepts are not synonymous. Patient centeredness is a concept well established in high-income countries that has been shown to improve health outcomes and reduce costs [90, 91]. Key dimensions of patient centeredness include improved patient-provider relationships, recognition that a patient's care exists in the context of their entire life (biopsychosocial perspective), and shared responsibility and decision-making. Patient-centeredness training, such as that developed in the PRIME intervention in Uganda for malaria care, should be adapted and scaled for HIV care and treatment [92].

Quality Improvement

Implementation of quality improvement strategies is essential for DSD systems to achieve the stated goal of maximizing efficiency without compromising service quality. If there are current gaps in facility-based service provision (i.e., poor laboratory testing infrastructure, frequent pharmacy stock-outs) then DSD will not fix these problems, and in fact may amplify them. Increased deployment of community HCW also poses a new challenge in ensuring health care quality [93, 94]. Application of quality-improvement methods, including iterative use of local data to identify gaps in care and test solutions, is critical.

Table 1 Suggested DSD research agenda

• Mediation and transportability analysis to improve understanding of DSD mechanism of effect and transportability of effectiveness findings
• Qualitative and quantitative evaluation of reasons for disengagement from DSD models
• Comparative cost-effectiveness of common DSD models for both stable and unstable patients
• Sustainability and long-term outcomes of DSD programs implemented at scale

Health System Responsiveness

It is already evident that patients' needs and preferences within DSD models are dynamic and health systems must be sufficiently flexible and adaptive to allow for titration of service intensity and frequency over time. Migration, job changes, pregnancy, and development of opportunistic infections or comorbidities are frequent causes for disengagement from DSD models of care. Successful monitoring and evaluation platforms will need to account for frequent migration into and out of DSD models.

Conclusions

While DSD represents an exciting and promising "next step" in HIV health care delivery, it has already become clear that it is not a panacea and comes with its own set of challenges. Evidence on the effectiveness of DSD generally supports the use of most DSD models, although it is still unclear which models are most relevant in diverse settings and populations and which are the most cost-effective. Further research is needed in these and several other key areas (Table 1). Challenges during scale-up highlight the need for accurate differentiation of patients, sustainable inclusion of a new cadre of health care worker (the community HCW), and substantial strengthening of existing pharmacy supply chains. Understanding reasons for patient disengagement from various DSD models of care and long-term outcome data will additionally help determine DSD model sustainability. Finally, to maximize the public health impact of DSD, systems need to be patient-centered and adaptive, as well as employ robust quality improvement processes.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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